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(54) **ON-DEMAND MOBILE WIRELESS BROADCAST VIDEO DELIVERY MECHANISM**

(71) Applicant: **AT&T MOBILITY II LLC**, Atlanta, GA (US)

(72) Inventors: **Jun Shen**, Redmond, WA (US); **Yung Shirley Choi-Grogan**, Issaquah, WA (US); **Ming Zhang**, Bellevue, WA (US)

(73) Assignee: **AT&T MOBILITY II LLC**, Atlanta, GA (US)

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Related U.S. Application Data

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(51) **Int. Cl.**

H04N 21/61	(2011.01)
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H04N 21/647	(2011.01)
H04N 21/2385	(2011.01)

(Continued)

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(58) **Field of Classification Search**

CPC H04N 21/222; H04N 21/2221; H04N 21/231; H04N 21/2393; H04N 21/2402; H04N 21/60; H04N 21/6106; H04N 21/6131; H04N 21/6137; H04N 21/6181; H04N 21/647; H04N 21/64707

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,710,702 B1	3/2004	Averbuch et al.
6,865,169 B1	3/2005	Quayle et al.

(Continued)

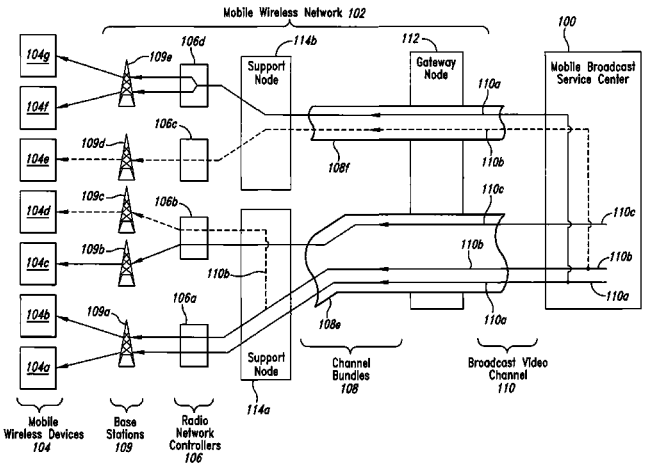
Primary Examiner — Ricky Chin

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLC; Andrew Gust

(57) **ABSTRACT**

A mobile broadcast service center and a mobile wireless network to deliver broadcast video to mobile wireless devices is described. When the mobile broadcast service center receives a request to deliver a broadcast video channel to a target mobile wireless device, it designates as target an intermediate node in the network that serves the target mobile wireless device. The mobile broadcast service center first determines if an existing channel bundle is routed to the target intermediate node. If this first determination is negative, the mobile broadcast service center routes a new channel bundle to the target intermediate node, including the requested broadcast video channel. If the first determination is positive, the mobile broadcast service center then determines if the requested broadcast video channel is in the existing channel bundle. If this second determination is negative, then it adds the requested broadcast video channel to the existing channel bundle.

20 Claims, 5 Drawing Sheets



(51) **Int. Cl.**

H04N 21/414	(2011.01)
H04N 21/266	(2011.01)
H04N 21/239	(2011.01)
H04N 21/231	(2011.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,035,636	B1	4/2006	Lim et al.
7,346,023	B2	3/2008	Chuah
7,522,598	B2	4/2009	Wong et al.
7,574,724	B2	8/2009	Tannenbaum
8,018,909	B2	9/2011	Ahlen et al.
8,081,609	B2	12/2011	Balachandran et al.
8,615,238	B2	12/2013	Eyuboglu et al.
8,707,376	B1	4/2014	Hannum et al.
2002/0108117	A1	8/2002	Sedlak et al.
2003/0076803	A1	4/2003	Chuah
2003/0194992	A1	10/2003	Kim et al.
2005/0220322	A1	10/2005	Olesen et al.
2006/0025157	A1	2/2006	Kuwahara et al.
2006/0029078	A1	2/2006	Lu et al.
2006/0083253	A1	4/2006	Park et al.
2006/0167979	A1	7/2006	Fuchs et al.
2007/0070949	A1	3/2007	Hwang et al.
2007/0197222	A1	8/2007	Rune
2007/0287473	A1	12/2007	Dupray
2008/0153461	A1	6/2008	Chan et al.
2008/0155112	A1	6/2008	Ma et al.
2008/0242224	A1	10/2008	Fratti et al.
2008/0242280	A1	10/2008	Shapiro et al.
2009/0006625	A1	1/2009	Gutknecht et al.
2009/0007189	A1	1/2009	Gutknecht et al.
2009/0119728	A1	5/2009	Broberg
2011/0230216	A1	9/2011	Amirijoo et al.
2012/0072966	A1	3/2012	Chen et al.

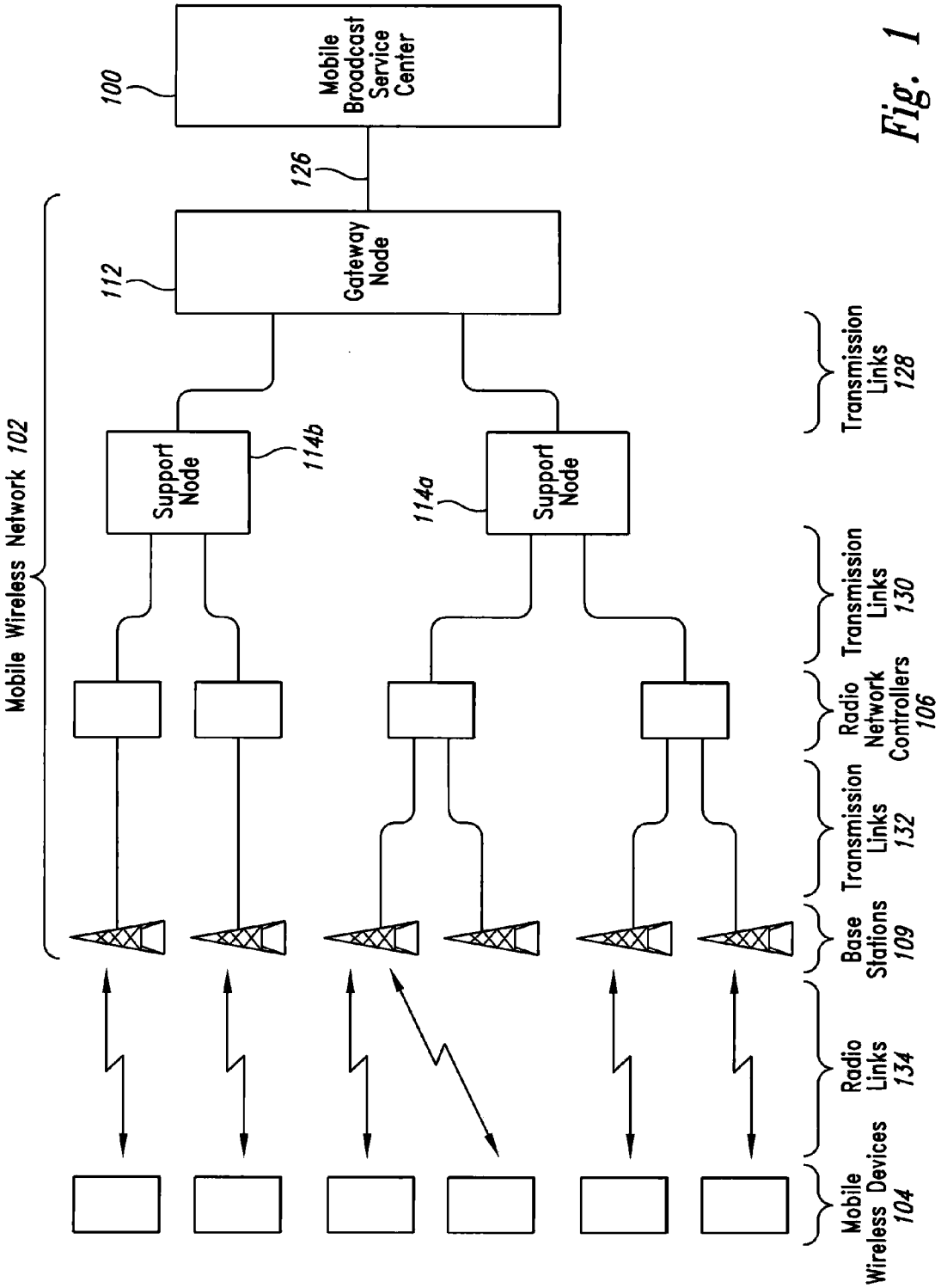

Mobile Broadcast Service Center
100
126
Gateway Node
112
Support Node
114b
Support Node
114a
Mobile Wireless Network 102
Transmission Links 128
Transmission Links 130
Radio Network Controllers 106
Transmission Links 132
Base Stations 109
Radio Links 134
Mobile Wireless Devices 104

Fig. 1

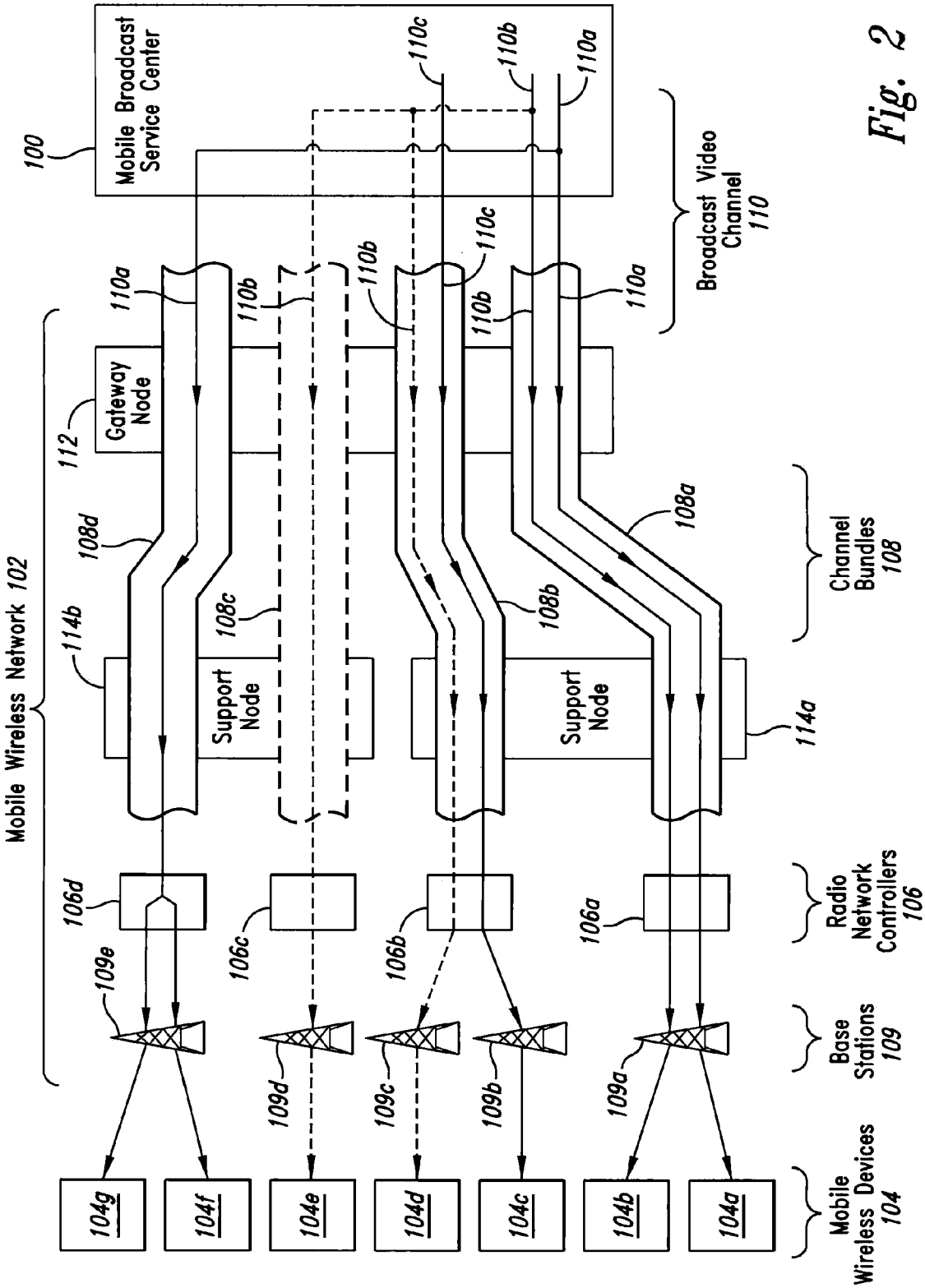

Mobile Broadcast Service Center
100
Broadcast Video Channel 110
110a
110b
110c
Gateway Node
112
Mobile Wireless Network 102
Support Node
114a
114b
Channel Bundles 108
108a
108b
108c
108d
Radio Network Controllers 106
106a
106b
106c
106d
Base Stations 109
109a
109b
109c
109d
109e
Mobile Wireless Devices 104
104a
104b
104c
104d
104e
104f
104g

Fig. 2

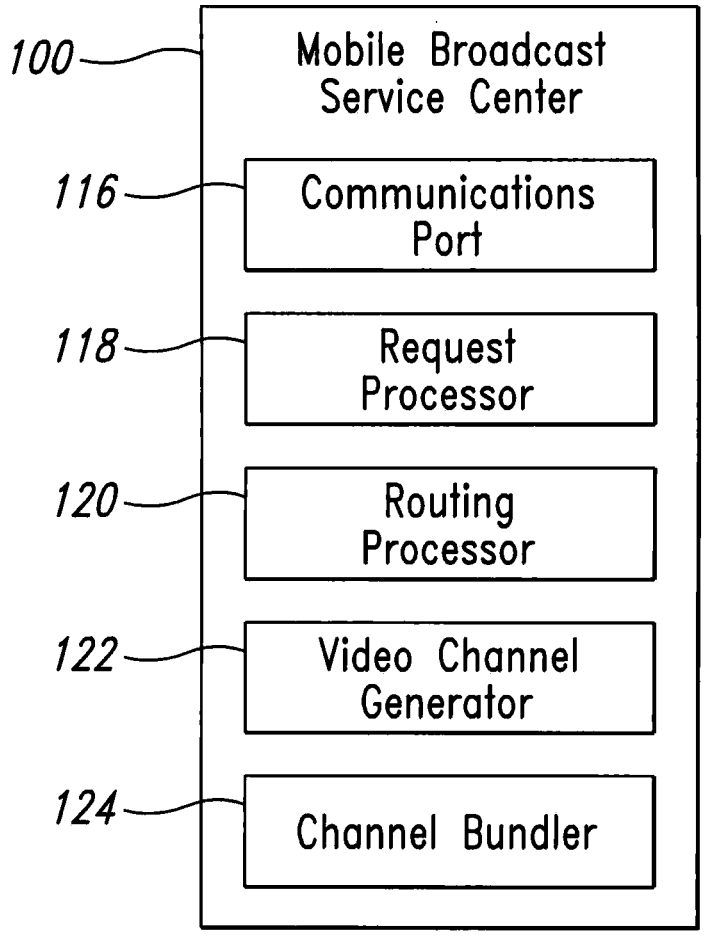

100
Mobile Broadcast Service Center
116
Communications Port
118
Request Processor
120
Routing Processor
122
Video Channel Generator
124
Channel Bundler

Fig. 3

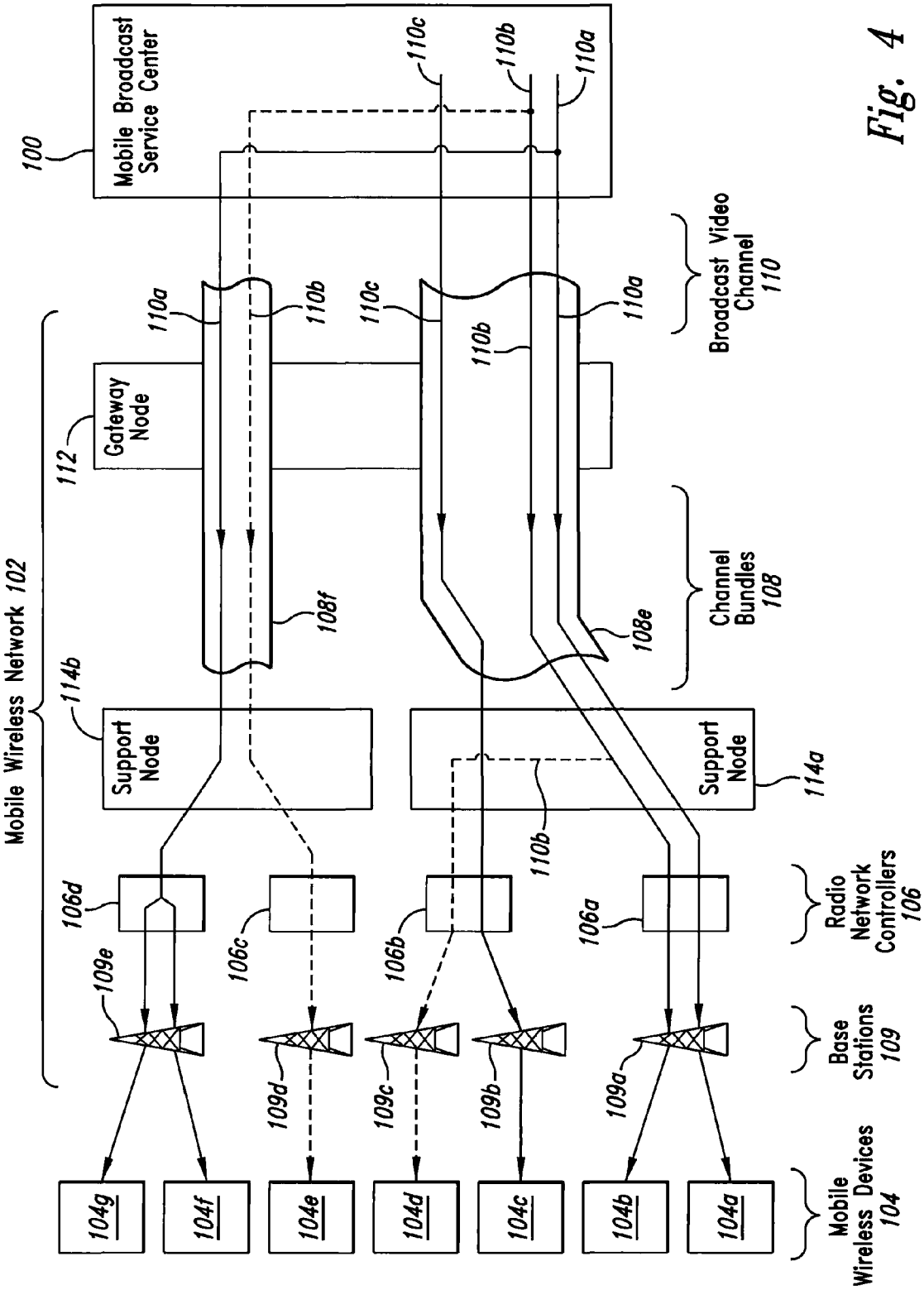

100
Mobile Broadcast Service Center
110c
110b
110a
Broadcast Video Channel 110
Gateway Node
112
Mobile Wireless Network 102
Channel Bundles 108
108f
108e
114b
Support Node
114a
Support Node
106d
106c
106b
106a
Radio Network Controllers 106
109e
109d
109c
109b
109a
Base Stations 109
104g
104f
104e
104d
104c
104b
104a
Mobile Wireless Devices 104

Fig. 4

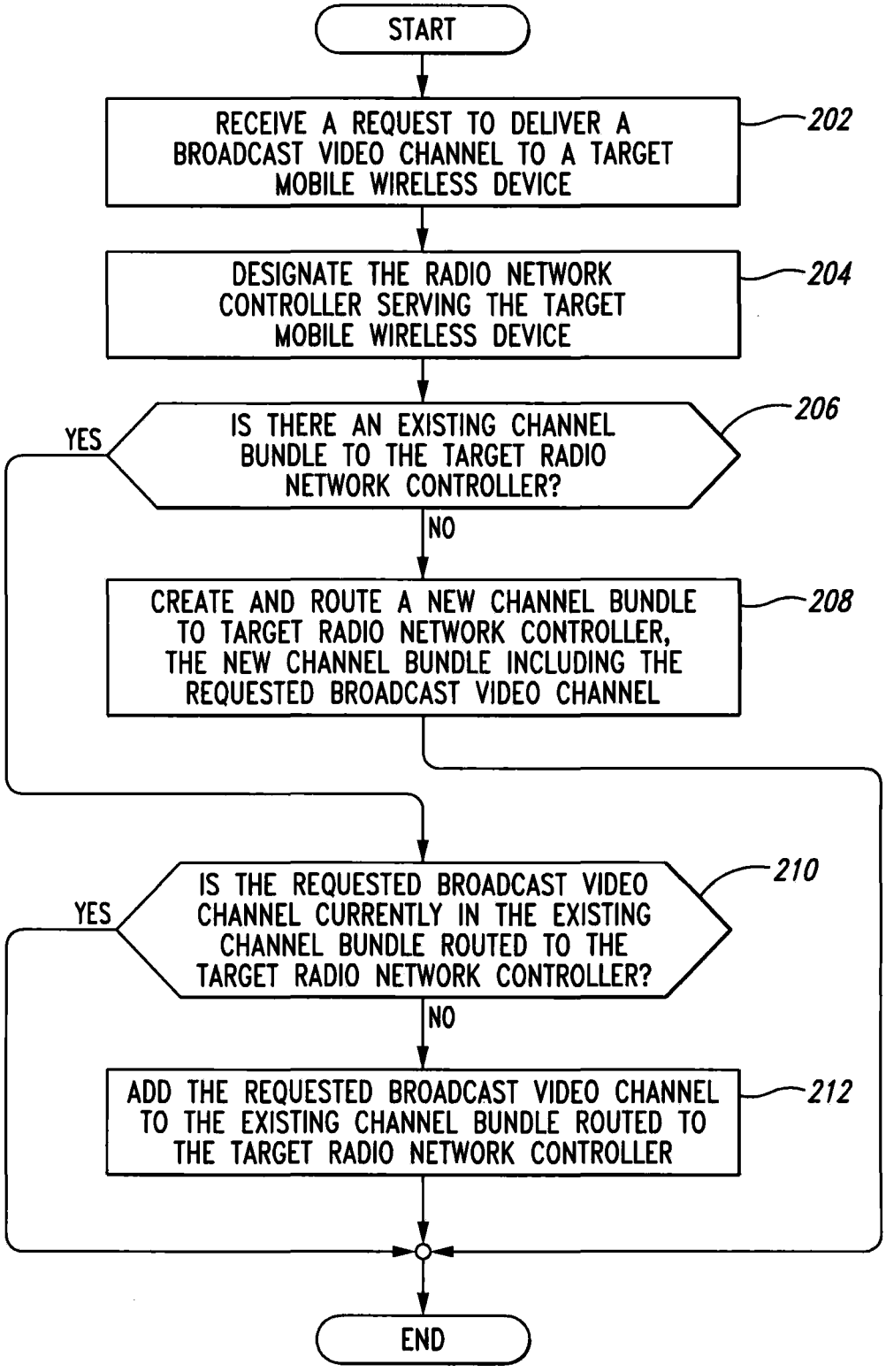

START
RECEIVE A REQUEST TO DELIVER A BROADCAST VIDEO CHANNEL TO A TARGET MOBILE WIRELESS DEVICE
202
DESIGNATE THE RADIO NETWORK CONTROLLER SERVING THE TARGET MOBILE WIRELESS DEVICE
204
IS THERE AN EXISTING CHANNEL BUNDLE TO THE TARGET RADIO NETWORK CONTROLLER?
206
YES
NO
CREATE AND ROUTE A NEW CHANNEL BUNDLE TO TARGET RADIO NETWORK CONTROLLER, THE NEW CHANNEL BUNDLE INCLUDING THE REQUESTED BROADCAST VIDEO CHANNEL
208
IS THE REQUESTED BROADCAST VIDEO CHANNEL CURRENTLY IN THE EXISTING CHANNEL BUNDLE ROUTED TO THE TARGET RADIO NETWORK CONTROLLER?
210
YES
NO
ADD THE REQUESTED BROADCAST VIDEO CHANNEL TO THE EXISTING CHANNEL BUNDLE ROUTED TO THE TARGET RADIO NETWORK CONTROLLER
212
END

Fig. 5

ON-DEMAND MOBILE WIRELESS BROADCAST VIDEO DELIVERY MECHANISM

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a continuation of U.S. patent application Ser. No. 14/251,293 filed Apr. 11, 2014 by Shen et al., entitled "On-Demand Mobile Wireless Broadcast Video Delivery Mechanism," which is a continuation of U.S. patent application Ser. No. 11/936,452 filed Nov. 7, 2007 by Shen et al., (now U.S. Pat. No. 8,732,778). All sections of the aforementioned applications are incorporated herein by reference in their entirety.

FIELD OF THE DISCLOSURE

The present invention is directed generally to mobile wireless network services. In particular, the invention is directed to a delivery mechanism for delivering broadcast video channels to mobile wireless devices.

BACKGROUND

Operators of mobile wireless networks want to offer their users a variety of broadcast video channels. A broadcast video channel is a broadcast video channel that can be viewed by many different users at the same time. Each user will see the same part of the video at the same time as other users. In contrast, a streamed broadcast video channel is a broadcast video channel that is sent only to a user that requests it. The same streaming video may be requested by different users, but each user will receive their own stream. Each streaming video user will see a different part of the video than the other users viewing at the same time.

Currently, to deliver broadcast video channels to mobile wireless devices, a network operator uses a server called a mobile broadcast service center to route a set of all the broadcast video channels the network operator offers through a wireless mobile communication network to each radio network controller in the network.

Routing a set of all offered broadcast video channels to each radio network controller has the advantage that little or no modifications need to be made to the mobile wireless network. However, routing a set of all offered broadcast videochannels to each radio network controller is not an efficient use of transmission links in the network. This practice is inefficient since channels routed to a radio network controller are not forwarded unless requested for mobile wireless devices served by that radio network controller, and many are usually not requested at any one time. This inefficiency becomes worse as the network operator offers more channels since the ratio between the number of channels requested and the number offered usual becomes smaller. Compounding the inefficiency is the fact that requests for broadcast video channels are not evenly distributed geographically. Mobile video users are concentrated in some areas such as urban centers and most of the time their usage is limited to several popular broadcast video channels. In some areas, some channels may never be requested.

The cost of transport for broadcast video channels across the network transmission links is significant and this cost is highest on the transmission links nearer the network edge (i.e., the base stations). What is needed is a way to route broadcast video channels responsive to requests in order to minimize use of the network transmission links, particularly those nearer the network edge, while minimizing the amount of changes to the mobile wireless network.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. **1** shows a mobile broadcast service center connected to a mobile wireless network.

FIG. **2** shows an overall view of the mobile wireless network and the mobile broadcast service center together providing broadcast video to mobile wireless devices.

FIG. **3** shows a detailed view of the mobile broadcast service center and its constituent components.

FIG. **4** shows an overall view of the mobile wireless network providing broadcast video to mobile wireless devices in a distributed network architecture.

FIG. **5** shows a flow chart of a method for a mobile broadcast service center to provide broadcast video services to users of mobile wireless devices through a mobile wireless network.

DETAILED DESCRIPTION

Several embodiments of the invention are show in the attached figures and discussed below. Multiple elements that are substantially similar to each other appear with a common reference number, but are distinguished by a differing reference letter suffix (e.g. **1000***a*, **1000***b*, etc.). Groups of substantially similar elements are referred to collectively by their common reference number without a suffix.

FIG. **1** shows a mobile broadcast service center **100** connected to a mobile wireless network **102**. The mobile broadcast service center **100** is configured to provide broadcast video channels to users of mobile wireless devices **104** through the mobile wireless network **102**.

The mobile wireless network **102** is comprised of various network elements including base stations **109**, radio network controllers **106**, support nodes **114**, at least one gateway node **112**, and includes various transmission links **128**, **130**, **132** between the network elements. The gateway node **112** has one or more interfaces that provide the mobile wireless network **102** the ability to connect to other networks and devices not part of the mobile wireless network **102**. The gateway node **112** is connected to one more or support nodes **114** via transmission links **128**. The support nodes **114** route traffic within the mobile wireless network **102**. Each support node **114** is connected to one or more radio network controllers **106** via transmission links **130**. Each radio network controller **106** is connected to and controls one or more base stations **109** via transmission links **132**. The base stations **109** serve mobile wireless devices **104** associated with the mobile wireless network **102** via radio links **134**. Thus, the mobile broadcast service center **100** and the mobile wireless devices **104** may be considered terminal nodes in a video delivery network while portions of the mobile wireless network, such as the radio network controllers **106**, have stations **109**, gateway node **112** and support nodes **114** may be considered intermediate nodes through which data is routed.

Each mobile wireless devices **104** may be served by one of the base stations **109**, usually the base station **109** that the particular mobile wireless device **104** has the best quality radio link **134** with. When one of the mobile wireless devices **104** moves, the quality of the radio link **134** to the serving base station **109** may change. Conventional handoff procedures are used to switch service for the moving mobile wireless device **104** to a different base station **109**.

In one embodiment, the mobile wireless network **102** conforms to the Universal Mobile Telecommunications Service (UMTS) standard. In such an embodiment, one of the base stations **109** corresponds to a UMTS Node B, the radio network controllers **106** correspond to UMTS Radio Network Controllers (RNCs), the support nodes **114** correspond to UMTS Serving GPRS Support Nodes (SGSNs)(where GPRS is General Packet Radio Service), the gateway node **112** corresponds to a UMTS GPRS Gateway Support Node (GGSN), and the various transmission links **128**, **130**, **132** comply with the appropriate UMTS interface standards.

FIG. **2** shows an overall view of the mobile wireless network **102** and the mobile broadcast service center **100** together providing broadcast video to mobile wireless devices **104**. The mobile broadcast service center **100** is configured to generate broadcast video channels **110**. The mobile broadcast service center **100** is configured to pack the broadcast video channels **110** into channel bundles **108**. The mobile broadcast service center may pack one of the broadcast video channels **110** into more than one of the channel bundles **108**. For example, broadcast video channel **110***a* is packed into channel bundles **108***a* and **108***d*. The radio network controllers **106** are each configured to terminate a channel bundle **108** and forward each included broadcast video channel **110** to base stations **109** that have a demand for that broadcast video channel **110**. Each base station **109** is configured to broadcast the broadcast video channels **110** forwarded to it. Several examples of how channel bundles **108** are created, packed and routed are given below.

In a first example, FIG. **2** shows a channel bundle **108***a* containing two broadcast video channels **110***a*, **110***b*. The mobile broadcast service center **100** generates broadcast video channel **100***a* responsive to a request to deliver the broadcast video channel **110***a* to a mobile device **104***a*. The mobile broadcast service center **100** generates broadcast video channel **110***b* responsive to a request to deliver the broadcast video channel **110***b* to a mobile device **104***b*. The mobile broadcast service center **100** creates channel bundle **108***a* and packs it with the broadcast video channels **110***a* and **110***b*. The mobile broadcast service center **100** routes the channel bundle **108***a* via the gateway node **112** to the radio network controller **106***a* serving mobile wireless devices **104***a* and **104***b*. The gateway node **112** forwards the channel bundle **108***a* to the intervening support node **114***a*. Support node **114***a* forwards the channel bundle **108***a* to radio network controller **106***a*. Radio network controller **106***a* terminates channel bundle **108***a* and forwards the formerly bundled broadcast video channels **110***a* and **110***b* to the base station **109***a*. The base station **109***a* broadcasts the channels **110***a* and **110***b*, which the mobile devices **104***a* and **104***b* respectively receive.

In a second example, FIG. **2** shows a channel bundle **108***b* containing broadcast video channel **110***c*. The mobile broadcast service center **100** generates broadcast video channel **110***c* responsive to a request to deliver the broadcast video channel **110***c* to a mobile device **104***c*. The mobile broadcast service center **100** creates channel bundle **108***b* that initially is packed only the requested broadcast video channel **110***c*. The mobile broadcast service center **100** routes channel bundle **108***b* via the gateway node **112** to the radio network controller **106***b* serving mobile wireless device **104***c*. The gateway node **112** forwards the channel bundle **108***b* to the intervening support node **114***a*. The support node **114***a* forwards the channel bundle **108***b* to the target radio network controller **106***b*. The target radio network controller **106***b* terminates the channel bundle **108***b*. The target radio network controller **106***b* then decides where to route the unbundled broadcast video channel **110***c*. The target radio network controller **106***b* controls base stations **109***b* and **109***c*. The target mobile device **104***c* is served by base station **109***b*. The other base station **109***c* serves another mobile device **104***d*, which has not yet requested a broadcast video channel **110**. The target radio network controller **106***b* forwards the broadcast video channel **110***c* to the base station **109***b*, but not to the base station **109***c*. The base station **109***b* then broadcasts the channel **110***c*, which may be received by the target mobile wireless service **104***c*.

In third example, FIG. **2** shows a channel bundle **108***d* containing broadcast video channel **110***a*. The mobile broadcast service center **100** has received a request to delito deliver the broadcast video channel **110***a* to a mobile device **104***f*. Mobile device **104***f* is served by radio network controller **106***d*. Broadcast video channel **110***a* was already requested by the first mobile wireless device **104***a* and included in channel bundle **108***a*. However, the channel bundle **108***a* also contains the broadcast video channel **110***b*, which has not been requested by any mobile wireless device **104** served by the radio controller **106***d*. It would be inefficient to send a copy of the channel bundle **108***a* with an unrequested broadcast video channel **110***b* to the radio controller **106***d*. Instead, the mobile broadcast service center **100** creates a channel bundle **108***d* packed only with the broadcast video channel **110***a*. The mobile broadcast service center **100** routes the channel bundle **108***d* to the radio network controller **106***d* via the gateway node **112**. The gateway node **112** forwards the channel bundle **108***d* to the intervening support node **114***b*. The intervening support node **114***b* forwards the channel bundle **108***d* to the radio network controller **106***d*. The radio network controller **106***d* terminates the channel bundle **108***d* and forwards the unbundled broadcast video channel **110***a* to the base station **109***e*. The base station **109***e* then broadcasts the channel **110***a*, which may be received by the mobile wireless device **104***f*.

In a fourth example, FIG. **2** shows a radio network controller **106***c* that serves a single mobile wireless device **104***e* through base station **109***d*. No broadcast video channel **110** has currently been requested to be delivered to mobile wireless device **104***e*. Thus no channel bundle **108** is currently routed to radio network controller **106***c*.

FIG. **3** shows a detailed view of the mobile broadcast service center **100** and its constituent components. The mobile broadcast service center **100** includes a communications port **116**, a request processor **118**, a routing processor **120**, a broadcast video channel generator **122**, and a channel bundler **124**.

The mobile broadcast service center **100** is configured to create channel bundles **108**. These bundles facilitate routing of broadcast video channels **110** throughout the mobile wireless network **102**. In some embodiments the channel bundles **108** comprise one or more broadcast video channels **110** packed into an additional data frame with its own overhead (or header) separate from the overhead of the individual broadcast video channels **110**. In these embodiments, the mobile broadcast service center **100** is configured route a channel bundle by placing routing instructions for a destination in the overhead of the channel bundle **108**. Elements of the mobile wireless network **102** are configured to forward the channel bundle **108** using the overhead in the channel bundle **108** to make routing decisions, not the overhead of the individual broadcast channels **110**.

However, in other embodiments the channel bundles **108** are largely conceptual. That is, each channel bundle **108** comprises a list in the mobile broadcast service center **100** of broadcast video channels **110** to be routed to a common

destination. In these embodiments, the mobile broadcast service center **100** is configured route a channel bundle **108** by placing routing instructions for the same destination in the overhead of each broadcast video channel **110** in a particular channel bundle **108**. Elements of the mobile wireless network **102** are configured to forward the channel bundle **108** using the overhead in the individual broadcast channels **110** to make routing decisions.

The communications port **116** provides the capability to connect the mobile broadcast service center **100** to a mobile wireless network such as the mobile wireless network **102** shown in FIG. **2**. Typically, the mobile broadcast service center **100** will be co-located in the same building as the gateway node **112** that serves as an access point for the mobile wireless network **102**. The mobile broadcast service center **100** may have more than one communications port **116**. In instances where the mobile broadcast service center **100** is co-located with the gateway node **112** the communications port **116** may be constructed according to an appropriate short range transmission protocol such as Ethernet, gigabit Ethernet, or ten gigabit Ethernet. A person of skill in the art will appreciate that another short range transmission protocol may be used instead. In instances where the mobile broadcast service center **100** is not co-located in the same building with the gateway node **112** then the communications port **116** will be constructed according to an appropriate intermediate range or long range transmission protocol such as OC-48 or OC-192. A person of skill in the art will appreciate that another long range transmission protocol may be used instead.

The request processor **118** provides a facility to process broadcast video channels requests. The request processor **118** receives a request for a broadcast video channel **110**, examines the request, identifies the requested broadcast video channel **110** and designates one of the mobile wireless devices **104** as a target for delivery of the requested broadcast video channel. In some embodiments, the request may originate from the target mobile wireless device **104**. The target mobile wireless device **104** can transmit the request to the one of the base stations **109** that is currently serving the target mobile wireless device **104**. This base station **109** can forward the request to the mobile wireless network **102**. The mobile wireless network may deliver the request to the mobile broadcast service center **100** through the communications port **116**. A person of skill in the art will appreciate that the request may reach the request processor **118** via other paths and from other sources. In some embodiments, a user may submit the request via an internet connection to the mobile broadcast service center **100**.

A routing processor **120** in the mobile broadcast service center **100** is configured to designate one of the radio network controllers **106** as a target for delivery of a requested broadband broadcast video channel. The routing processor **120** has logic that will designate one of the radio network controllers **106** that is currently serving the target mobile wireless device **104** as the target radio network controller **106**.

As previously discussed, the mobile broadcast service center **100** is configured to create channel bundles **108**. The routing processor **120** may function to generate the necessary headers to assure proper routing. In the embodiment where one or more broadcast video channels **110** are packed into channel bundles **108**, the routing processor **120** may generate the header data for the bundle of multiple broadcast video channels. Alternatively, the routing processor **120** may generate the necessary headers for the individual ones of the broadcast video channels **110** to be routed to a common destination.

The video channel generator **122** of the mobile broadcast service center **100** has facilities to generate broadcast video channels **110**. The methods for the mobile broadcast service center **100** to generate video content are not limited. For example, in some embodiments, the video channel generator **122** generates video channels by accessing storage media where video content for the video channel is stored. The storage media may be a component of the mobile broadcast service center **100**. Alternatively, the storage media may be external to and connected with the mobile broadcast service center **100**. In other embodiments, the video channel generator **122** generates video channels by receiving a signal carrying video content from outside the mobile broadcast service center **100**.

The channel bundler **124** of the mobile broadcast service center **100** is configured to pack broadcast video channels **110** into channel bundles **108**. The channel bundles **108** may be sent out the communications port **116**. The channel bundler **124** has logic to determine if an existing channel bundle **108** is routed to the target radio network controller **106** and determine if it already includes the requested broadcast video channel **110**. The channel bundler **124** has logic to add the requested broadcast video channel **100** to an existing channel bundle **108** routed to the target radio network controller **106** if the existing channel bundle **108** does not already include the requested broadcast video channel **108**. The channel bundler **124** has logic to route a new channel bundle **108**, to the target radio network controller **106** if no broadcast video channel bundle **108** exists that is routed to the target radio network controller **106**. The new channel bundle **108** would include the requested broadcast video channel **110**.

In the embodiment described above, the mobile broadcast service center **100** designates one of the radio network controllers **106** as the target radio network controller and destination for one or more of the broadcast video channels **110** in a bundle **108**. In this embodiment, intermediate nodes, such as the gateway node **112**

and the support node **114** effectively act as routers that simply relay the data frames to the appropriate destination (i.e., the target network controller **106**). In this embodiment, the gateway node **112** and the support nodes **114** may operate at the network level in an OSI model to transport and route the message (i.e., the broadcast video channels **110**) to their proper destination.

However, in an alternative embodiment, the intermediate nodes (i.e., the gateway node **112** of the support nodes **114**) may have additional intelligence. In this embodiment, the intermediate nodes have knowledge of the specific broadcast video channels being processed by the nodes.

This distributed network architecture allows for a different delivery paradigm for the broadcast video channels **110**. FIG. **4** illustrates this distributed network architecture. In a first example, the video broadcast channel **110***a* has been requested by the mobile wireless devices **104***f*-**104***g*. The requested broadcast video channel (i.e., the broadcast video channel **110***a*) is provided by the mobile broadcast service center **100** to the radio network controller **106***d* via the gateway node **112** and the support node **114***b*. In addition to providing routing functions, the gateway node **112** and the support node **114***b* also operate at an application level in the OSI model to detect and monitor the transmissions. That is, the gateway node **112** and the support node **114***b* are aware that they are relaying the broadcast video channel **110***a*. In this example, the mobile wireless device **104***e* transmits a request to receive the mobile broadcast channel **110***b*. As previously described, this request is relayed through the mobile wireless network **102**. However, at each intermediate

node (i.e., the support node **114***b* and the gateway node **112**), the mobile wireless network analyzes the request to determine whether that particular intermediate node is already processing the requested broadcast video channel (i.e., the broadcast video channel **110***b*). In this example, neither the gateway node **112** nor the support node **114***b* are currently processing the requested broadcast video channel **110***b*. In this event, the request for the broadcast video channel **110***b* is relayed to the mobile broadcast service center **100**. The mobile broadcast service center responds in the manner previously described to add the requested broadcast video channel **110***b* to the channel bundle **108***f*. In this manner, the requested broadcast video channel **110***b* is routed to the radio network controller **106***c*. The intermediate nodes (i.e., the gateway node **112** and the support node **114**) are configured not only to relay the requested broadcast video channel **100***b*, but to maintain awareness that this new broadcast video channel is being processed by the intermediate nodes.

In a second example, the channel bundle **108***e* contains broadcast video channels **110***a*-**110***c*. The broadcast video channels **110***a*-**110***b* are routed from the mobile broadcast service center **100** to the radio network controller **106***a* via the gateway node **112** and the support node **114***a*. The broadcast video channel **110***c* is routed from the mobile broadcast service center **100** to the radio network controller **106***b* via the gateway node **112** and the support node **114***a*. As described above, the intermediate nodes (i.e., the gateway node **112** and the support node **114***a*) have application level intelligence that allows it to determine the identity of the broadcast video channels being routed through those intermediate nodes.

In this second example, the mobile wireless device **104***d* transmits a request for broadcast video channel **110***b*. The radio network controller **106***b* relays that request to the support node **114***a*. In the first embodiment described herein, the support node **114***a* simply relays the request through the mobile wireless network **102** to the mobile broadcast service center **100**. However, in the second embodiment, the support node **114***a* is configured to operate at an application level and monitors the broadcast video channels being transmitted via the support node **114***a*. In this example, the mobile wireless device **104***d* has requested a broadcast video channel (i.e., the broadcast video channel **110***b*) that is already being processed the support node **114***a*. In this case, it is unnecessary for the support node **114***a* to relay the request any farther through the mobile wireless network **102**. Instead, the support node **114***a* is configured to route the requested broadcast video channel **110***b* to the radio network controller **106***b* as well as continuing to route the requested broadcast video channel **110***b* to the radio network controller **106***a*. In this embodiment, the distributed network architecture only requires that a request for a broadcast video channel be relayed to a point in the mobile wireless network **102** where that requested broadcast video channel already exists.

FIG. **5** shows a flow chart for a method of a mobile broadcast service center **100** to connect to a mobile wireless network **102** and deliver channel bundles **108** of broadcast video channels **110**.

In step **202**, the mobile broadcast service center **100** receives a request to deliver a broadcast video channel **110** to a target mobile wireless device **104**. In some embodiments, this request is generated by the target mobile wireless device **104** itself and transmitted to the base station **109** that is currently serving the target mobile wireless device **104**. The base station **109** then forwards the request over the mobile wireless network **102**. In other embodiments, the mobile network mobile broadcast service center **100** receives the request by other means. In one embodiment, a user may submit the request for a broadcast video channel **110** through a website.

For an example of step **202**, presume the mobile wireless device **104***d* of FIG. **2** requests to receive a new broadcast video channel **110***b* that is not currently generated by the mobile broadcast service center **100**. This request is forwarded through the mobile wireless network **102** via the base station **109***c* serving the requesting mobile wireless device **104***d*. The base station **109***c* forwards the request to the radio network controller **106***b* that controls the base station **109***c*. The radio network controller **106***b* forwards the request to the intermediate support node **114***a*, which forwards the request to the gateway node **112**. Finally, the gateway node **112** forwards the request to mobile broadcast service center **100**. The mobile broadcast service center **100** examines the request, identifies the requested broadcast video channel as new channel **110***d*, and designates the mobile wireless device **104***d* as the target mobile wireless device.

In step **204**, the mobile broadcast service center **100** designates a target radio network controller **106** for the requested broadcast video channel **110**. The mobile broadcast **102** to identify the radio network controller **106** serving the target mobile wireless device **104**. In another embodiment, the identity of the target radio network controller **106** serving the target mobile wireless device **104** may be included in or with the received request for the broadcast video channel **110**.

Thus, the request itself may include information identifying the target video network controller **106** and/or the target mobile wireless device **104**. In yet another alternative embodiment, the mobile broadcast service center **100** and/or the mobile wireless network **102** received periodic update messages from one or more intermediate nodes (e.g., the gateway node **112** and/or the support node **114**) serving the target mobile wireless device **104** that identifies itself as such.

For an example of step **204**, the previous example from step **202** is continued. The mobile broadcast service center **100** in FIG. **2** queries the mobile wireless network **102** to identify the radio network controller **106***b* that controls the base station **109***c* that serves the target mobile wireless device **104***d*. Upon reply, the mobile broadcast service center **100** designates the identified radio network controller **106***b* as the target radio network controller. Routing of the requested broadcast video channel (e.g., the broadcast video channel **110***c*) occurs in the manner described above.

In step **206**, the mobile broadcast service center **100** determines if there is an existing channel bundle **108** that is routed to the target radio network controller **106** but does not already include the requested broadcast video channel **110**. If there is such a channel bundle **108**, then step **208** is skipped in the process continues with step **210**. If there is no such existing channel bundle **108** routed to the target radio network controller **106**, then step **208** is performed wherein the mobile broadcast service center **100** adds the requested broadcast video channel to that existing channel bundle **108**.

For an example of step **206**, the previous example from step **204** is continued. The mobile broadcast service center **100** determines that an existing channel bundle **108***b* is routed to the target radio network controller **106***b* (i.e., the result of step **206** is YES). In that event, the mobile broadcast service center **100** moves to step **210** to determine whether the requested broadcast video channel **110** is currently in the existing channel bundle **108** routed to the target radio network controller **106**.

However, if the mobile broadcast service center **100** determines that there is no existing channel bundle to the target radio network controller, the result of step **206** is NO. This is illustrated in FIG. **2** with the mobile wireless device **104***e*

requesting the broadcast video channel **110***b*. In this example, the mobile wireless device **104***e* is coupled to the mobile wireless network **102** via the base station **109***d*, which is controlled by the radio network controller **106***c*. Thus, the radio network controller **106***c* is designated as the target radio network controller. The request for the broadcast video channel **110***b* is routed from the radio network controller **106***c* to the mobile broadcast service center **100** via the support node **114***b* and the gateway node **112**. In executing step **206**, the mobile broadcast service center **100** would determine that there is no existing channel bundle to the target radio network controller **106***c*. In that event, the mobile broadcast service center executes step **208** to route a new channel bundle (e.g., the channel bundle **108***c*) to the target radio network controller **106***c*. The channel bundle **108***c* contains the requested broadcast video channel **110***b*. The requested broadcast video channel **110***b* is routed to the target radio network controller **106***c* via the gateway node **112** and the support node **114***b*. The target radio network controller **106***c* relays the requested broadcast video channel **110***b* to the base station **109***d* for transmission to the mobile wireless device **104***e*.

In step **210**, the mobile broadcast service center **100** determines if the requested broadcast video channel is currently routed to the identified target radio network controller. If there is such a channel, then the result of step **210** is YES, and the method is terminated. If there is not, then step **212** is performed wherein the mobile broadcast service center **100** routes a new channel bundle to the target radio network controller with the new channel bundle including the requested broadcast video channel.

For an example of steps **210** and **212**, assume that mobile wireless device **104***e* in FIG. **2** had requested broadcast video channel **110***b*, the mobile broadcast service center **100** had designated mobile wireless device **104***e* as the target mobile wireless device and had designated the radio network controller **106***c* as the target radio network controller. The mobile broadcast service center **100** then determines that there is no broadcast video channel currently routed to the target radio network controller **106***c* (i.e., the result of step **206** is NO and the result of step **210** is NO). The mobile broadcast service center **100** then routes the new channel bundle **108***c* to the target radio network controller **106***c*. This new channel bundle **108***c* includes the requested broadcast video channel **110***b*.

Note, the requested broadcast video channel **110***b* was already packed in channel bundle **108***a* heading to radio network controller **106***a*. However, the mobile broadcast service center **100** would not route another copy of channel bundle **108***a* to the target radio network controller **106***c* because channel bundle **108***a* contains an additional broadcast video channel **110***a* that has not been requested by any mobile device served by the target radio network controller **106***c*.

In another example, consider the channel bundle **108***b*. The mobile wireless device **104***d* requests the video channel **110***b*. The request for the video channel **110***b* is routed to the mobile broadcast service center **100** via the base station **109***c*, the radio network controller **106***b*, the support node **114***a*, and the gateway node **112**. At the mobile broadcast service center **100**, it is determined that a channel bundle (i.e., the channel bundle **108***b*) already exists with the radio network controller **106***b* as the target radio network controller (i.e., the result of step **206** is YES). In that event, the mobile wireless network **102** need not create a new channel bundle (i.e., step **208** is skipped). In step **210**, the mobile broadcast service center **100** determines that the existing channel bundle **108***b* does not contain the requested broadcast video channel **110***b* (i.e., the result of step **210** is NO). In that case, the mobile broadcast service center **110** adds the requested broadcast video channel **110***b* to the existing channel bundle **108***b* routed to the target radio network controller **106***b*.

In the examples described above, the requests for broadcast video channels are routed to the mobile broadcast service center **100** via the mobile wireless network **102**. In this embodiment, the intermediate nodes (e.g., the gateway node **112** and the support nodes **114**) essentially operate as routers, in the manner described above. However, in the alternative embodiment described above, the intermediate nodes (e.g., the gateway node **112** and the support nodes **114**) operate at an application level and have an awareness of the broadcast video channels being routed therethrough. This embodiment, discussed above with respect to FIG. **4**, permits routing to and from the intermediate nodes. As described above, a request for a particular broadcast video channel need not be routed all the way back to the mobile broadcast service center **100** if the requested broadcast video channel is available at another node within the network, such as the gateway node **112**, the support nodes **114**, or the radio network controllers **106**.

In one example using the distributed network architecture of FIG. **4**, the mobile wireless device **104***d* requests the broadcast video channel **110***b*. This request is forwarded through the mobile wireless network **102** only as far as the support node **114***a*. Because the requested broadcast video channel **110***b* is present within the support node **114***a*, the support node is configured to route the requested broadcast video channel **110***b* through the radio network controller **106***b* to be broadcast by the base station **109***c* to the mobile wireless device **104***d*. Thus, in the embodiment of FIG. **4**, the request to deliver a broadcast video channel is relayed only to the point within the mobile wireless network **102** where the requested broadcast video channel is already present.

Those of ordinary skill in the art will appreciate that the flow chart of FIG. **5** can be applied to the network architecture illustrated in FIG. **4**. In the event that a mobile wireless device **104** requests a broadcast video channel **110** that is not presently available within the mobile wireless network **102**, the system illustrated in FIG. **4** operates in a manner similar to the system illustrated in FIG. **2**. For example, consider the mobile wireless device **104***e*, which has requested the broadcast video channel **110***b*. The request for the broadcast video channel **110***b* is relayed from the mobile wireless device **104***e* through the base station **109***d* to the radio network controller **106***c*. Because the requested broadcast video channel **110***b* is not available at the radio network **106***c*, the request is relayed from the radio network controller to the support node **114***b*. Since the requested broadcast video channel **110***b* is not present in the support node **114**, the support node relays the request to the gateway node **112**, which may relay the request for the broadcast video channel to the mobile broadcast service center **100**. Thus, the request for the broadcast video channel **110***b* relayed through the mobile wireless network **102** to the mobile broadcast service center **100**. It should be noted that the requested broadcast video channel in this example (i.e., the broadcast video channel **110***b*) is available in the support node **114***a*. However, since the target mobile wireless device **104***e* is not coupled to the support node **114***a*, the request is relayed to the gateway node **112**.

The mobile broadcast service center **100** determines that there is an existing channel bundle (i.e., the channel bundle **108***f*) that exists between the mobile broadcast service center **100** and the support node **114***b*. Thus, the result of step **206** is YES. In that event, the mobile broadcast service center determines that the requested broadcast video channel (i.e., the broadcast video channel **110***b*) is not currently in the existing channel bundle (i.e., the channel bundle **108***f*) routed to the

target radio network controller (i.e., the radio network controller **106***c*). Thus, the result of step **210** is NO and, at step **212**, the mobile broadcast service center **100** adds the requested broadcast video channel **110***b* to the existing channel bundle **108***f*. Thus, the requested broadcast video channel is relayed from the mobile broadcast service center to the radio network controller **106***c* via the gateway node **112** and the support node **114***b*. The requested broadcast video channel is subsequently relayed to the base station **109***d* for transmission to the mobile wireless device **104***e*.

In an alternative embodiment, it should be noted that the requested broadcast video channel in the above example (i.e., the broadcast video channel **110***b*) is present within the gateway node **112**. Thus, the gateway node **112** may operate at an application level to receive the request for the broadcast video channel **110***b* and to route the requested broadcast video channel from the gateway node **112** to the support node **114***b*. Accordingly, in this embodiment, the request for the broadcast video channel **110***b* need not be relayed from the gateway node **112** to the mobile broadcast service center. That is, the request for the broadcast video channel **110***b* terminates at the gateway node **112** because the gateway node is already receiving the requested broadcast video channel **110***b*.

In another example of the operation of the distributed architecture mobile wireless network, consider the request for the broadcast video channel **110***b* by the mobile wireless device **104***d*, shown in FIG. **4**. The request for the broadcast video channel **110***b* is received via the radio network controller **106***b* and relayed to the support node **114***a*. Because the support node **114***a* operates at an application level, the support node is aware that it already is receiving the requested broadcast video channel **110***b*. Thus, the support node **114***a* may execute portions of the flowchart of FIG. **5** to determine whether the requested broadcast video channel is available for routing to the target radio network controller (i.e., the radio network controller **106***b*). In this embodiment, the support node **114***a* routes the requested broadcast video channel **110***b* to the radio network controller **106***b*.

A system and method has been described for the creation of broadcast video channels **110** to be routed through a mobile wireless network **102**. The system also has the capability of terminating the broadcasts and deleting the broadcast video channels **110** from the mobile wireless network **102**. In some cases, the requested broadcast video channel may have a natural termination time. For example, the requested broadcast video channel could be a broadcast of a sporting event, which may have an indeterminate broadcast termination time. When the sporting event has ended, the broadcast video channel may be terminated by the mobile broadcast service center **100**. In another example, the requested broadcast video channel may be a conventional broadcast program, which has a determinate length (e.g., one hour).

When the program has terminated, the mobile broadcast service center **100** may terminate the requested broadcast video channel **110**. In yet another example, the user may request a broadcast video channel for a certain length of time. For example, the user may request a broadcast video channel of music video for some user-determined length of time (e.g., one hour, two hours, twenty-four hours, etc.).

Following the completion of the requested time period, the mobile broadcast service center **100** may terminate the broadcast video channel **110**. Other conventional techniques may be used to terminate the requested broadcast video channel **110**.

The components of described herein may in some embodiments be implemented as a computer processor coupled to a memory, the memory containing instructions that when executed by the computer processor, perform the functions as described above. In other embodiments, the components described herein may be realized as hard-wired circuits.

The foregoing described embodiments depict different components contained within, or connected with, different other components. It is to be understood that such depicted architectures are merely exemplary, and that in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that, based upon the teachings herein, changes and modifications may be made without departing from this invention and its broader aspects and, therefore, the appended claims are to encompass within their scope all such changes and modifications as are within the true spirit and scope of this invention. Furthermore, it is to be understood that the invention is solely defined by the appended claims. It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to inventions containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should typically be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, typically means at least two recitations, or two or more recitations).

Accordingly, the invention is not limited except as by the appended claims.

The Abstract of the Disclosure is provided with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited

in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.

What is claimed is:

1. A method, comprising:

routing, by a network device comprising a processor, streamed content over a first routing path towards a first radio network controller for delivery to a first base station that delivers the streamed content to a first mobile communication device, wherein the streamed content includes video content;

adjusting, by the network device, the first routing path to generate a second routing path, that includes a support node, for routing the streamed content to a second radio network controller for delivery to a second mobile communication device via a second base station while continuing to route the streamed content to the first radio network controller via the support node, wherein the routing of the streamed content to the second radio network controller is performed without providing a routing adjustment notification to equipment of a gateway node or to a mobile broadcast service center that initiated the streamed content;

receiving, by the network device from the equipment of the gateway node, the streamed content; and

adjusting, by the network device, a group of channel bundles according to channel bundle changes initiated by the mobile broadcast service center to satisfy user content requests, wherein routing information is added to a channel bundle, and wherein the routing information indicates that the streamed content is being delivered to the first radio network controller via the support node positioned in a network between the first radio network controller and the equipment of the gateway node.

2. The method of claim **1**, wherein the streamed content routed to the first and second radio network controllers comprises a simulcast transmission for simulcast delivery to the first and second mobile communication devices.

3. The method of claim **1**, comprising storing, by the network device, the routing information indicating that the streamed content is being delivered to the first radio network controller via the support node.

4. The method of claim **1**, comprising receiving, by the network device, a request from the second radio network controller to deliver the streamed content to the second mobile communication device.

5. The method of claim **4**, comprising:

determining, by the network device, that the request is not to be routed to the equipment of the gateway node or the mobile broadcast service center.

6. The method of claim **1**, further comprising obtaining, by the network device, an identity of the streamed content.

7. A machine-readable storage device, comprising executable instructions, which when executed by a processor of a network device, causes the processor to perform operations comprising:

receiving streamed content including video content initiated by a mobile broadcast service center that provides video services;

routing the streamed content over a first routing path towards a first radio network controller for delivery to a first base station that delivers the streamed content to a first mobile communication device;

determining that the streamed content is being delivered to the first radio controller via a support node according to routing information added to a channel bundle; and

adjusting the first routing path to generate a second routing path, originating at the support node, for routing the streamed content to a second radio network controller for delivery to a second mobile communication device via a second base station while continuing to route the streamed content to the first radio network controller via the support node, wherein the routing of the streamed content to the second radio network controller is performed without providing a routing adjustment notification to equipment of a gateway node or to the mobile broadcast service center, wherein the support node is positioned in a network between the first radio network controller and the mobile broadcast service center.

8. The machine-readable storage device of claim **7**, wherein the receiving of the streamed content is via the equipment of the gateway node.

9. The machine-readable storage device of claim **7**, wherein the adjusting of the first routing path to generate the second routing path is responsive to a delivery request originated at the second mobile communication device.

10. The machine-readable storage device of claim **9**, wherein the delivery request is received from the second radio network controller.

11. The machine-readable storage device of claim **9**, wherein the operations further comprise determining that the delivery request is not to be routed to the mobile broadcast service center.

12. The machine-readable storage device of claim **7**, wherein the streamed content routed to the first and second radio network controllers comprises a simulcast transmission for simulcast delivery to the first and second mobile communication devices.

13. The machine-readable storage device of claim **7**, wherein the operations further comprise obtaining an identity of the streamed content.

14. The machine-readable storage device of claim **13**, wherein the operations further comprise storing, by the network device, the routing information indicating that the streamed content is being delivered to the first radio network controller via the support node, wherein the storing of the routing information includes storing the identity of the streamed content.

15. A network device, comprising:

a memory that stores executable instructions; and

a processor coupled to the memory, wherein responsive to executing the instructions, the processor performs operations comprising:

routing streamed content including video content over a first routing path towards a first radio network controller for delivery to a first base station that delivers the streamed content to a first mobile communication device;

determining that the streamed content is being delivered to the first radio controller via a support node according to routing information included in a channel bundle; and

adjusting the first routing path to generate a second routing path, originating at the support node, for routing the streamed content to a second radio network controller for delivery to a second mobile communication device via a second base station while continuing to route the streamed content to the first radio network controller via the support node, wherein the routing of the streamed content to the second radio network controller is performed without providing a routing adjustment notifica-

tion to equipment of a gateway node that provided the streamed content or to a mobile broadcast service center, wherein the support node is positioned in a network between the first radio network controller and the equipment of the gateway node.

16. The network device of claim **15**, wherein the streamed content is initiated by the mobile broadcast service center.

17. The network device of claim **15**, wherein the operations further comprise storing the routing information indicating that the streamed content is being delivered to the first radio network controller via the support node, wherein the storing of the routing information includes storing an identity of the streamed content.

18. The network device of claim **15**, wherein a delivery request is received from the second radio network controller, wherein the adjusting of the first routing path to generate the second routing path is responsive to the delivery request, and wherein the operations further comprise determining that the request is not to be routed to the equipment of the gateway node.

19. The network device of claim **15**, wherein the streamed content routed to the first and second radio network controllers comprises a simulcast transmission for simulcast delivery to the first and second mobile communication devices.

20. The network device of claim **15**, wherein the operations further comprise obtaining an identity of the streamed content and storing the identity of the streamed content with the routing information.

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